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A pilot study on the Relationship between Mechanical and Electrical Loss Tangents of Glass Powder Reinforced Epoxy Composites Post-cured in Microwaves

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Keywords: Epoxy resin hollow glass powder, dielectric loss tangent, mechanical loss tangent, glass transition temperature and storage modulus.

Abstract. The mechanical and thermal properties of hollow glass powder reinforced epoxy resin composites have been measured and evaluated in earlier studies. This basic but critical and important data have caused interests in the relevant industry in Australia. This study is therefore carried out to measure and evaluate the dielectric properties of the composites with a view to benefit the relevant industry. The relationship between the dielectric and thermal properties will also be studied and correlated. The original contributions of this paper are that samples post-cured in conventional ovens have higher electrical as well as mechanical loss tangent values than their counterparts cured in microwaves only. The storage modulus of all samples post-cured conventionally is higher than its counterpart. This is in line with the fact that they are softer material with lower glass transition temperatures. For all percentages by weight of glass powder, the glass transition temperature for the microwave cured sample was higher and the composite was stiffer; the opposite was true for the conventionally cured samples.

Introduction

The Centre for Excellence in Engineered Fibre Composites (CEEFC) at the USQ seeks to facilitate the development and introduction of lightweight composite materials into engineering commercial applications. The most widely used and least expensive polymer resins are the polyesters and vinyl esters; these matrix materials are used primarily for glass fiber-reinforced composites. The epoxies are more expensive and, in addition to commercial applications, are also utilized extensively in polymer matrix composites for aerospace applications; they have better mechanical properties and resistance to moisture than the polyesters and vinyl resins [1]. In this study, the dielectric properties of the prepared composites were investigated and were correlated with the thermal properties. The percentage by weight of glass powder studied was varied from 5 to 15 %. Half of the samples were post-cured conventionally and the other half of them was post-cured in microwaves.

The materials

The epoxy resin used in this study is Kinetix R246TX Thixotropic Laminating Resin, an opaque liquid, and the hardener used is kinetic H160 medium hardener which has a pot life of 120 minutes. Other hardeners like H126, H128, H161 and H162 can also be used [2]. The glass powder was first mixed with epoxy resin, after this the hardener, kinetic H160 medium was added. The by weight ratio of resin to hardener used was 4:1 [2]. The composite was then cast to moulds of tensile test pieces and left to cure under ambient conditions for 24 hours. The tensile test specimens were taken out of the moulds and then post-cured in oven at 40 °C for 16 hours, and then at 50 °C for 16 hours and finally at 60 °C for 8 hours. This is to ensure the heat distortion temperature (HDT) is above 63 °C. To bring